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BRAIN CENTRES.

By S. V. Clevenger, M. D.

Gradual and better understanding of the nature of the brain and its workings is being acquired and disseminated by investigators and thinkers (who are not always one and the same). Twenty years ago the most incorrect ideas concerning the brain existed, consisting of a mingling of superstition with the incorrect phrenological deductions of Gall, Spurzheim, and their followers. Fritsch and Hitzig by experimentation upon dogs, Ferrier upon anthropoid apes, and the imitators and elaborators of their methods, foremost among whom stands Munk, have prepared the way for thinking pathologists and histologists such as Exner, Meynert, Spitzka, and von Gudden, for verification of previous findings.

All too often the patient drudge of a microscopist, fully equipped with special technical knowledge, while able to accurately describe what he saw, was unable to interpret its significance, and quite as often those who are capable of making profound generalizations lack the data, the means or the time, necessary for research. A research with the brain is quite as important as that with the eyes or other sense organs. In fact it was not till the world had investigators with brains as well as eyes, such as Linné, Lamarck, Cuvier, and Darwin, that the investigating eyes knew what to look for, or recognized it when they had found it.

The methods by which the motor centres in the brain were localized are simple enough. After a piece of the skull of an animal was removed, electrical stimulation of certain definite parts of the bared brain invariably produced certain muscular movements. Applied at one point the fingers would move, at another a certain arm movement would occur, and thus leg, tail, face, and tongue movements were induced, and often the muscular coördinations thus evoked were quite complicated, as in swimming, grasping, running, and emotional expression. Cutting away these same small portions of brain tissue pro-

duced paralysis or loss of ability to voluntarily perform these same motions. Tumors or the rupture of blood vessels in these brain regions also cause these paralytic conditions and confirm the results of experimentation.

Destruction of other portions of the brain enabled the localizing of centres for the special senses, and thus we have ascertained that the optic centre is in the hindmost tip of the cerebrum, the auditory is two or three inches farther forward. The centres thus far accurately located are those for sight, and hearing and those controlling the motions of all parts of the extremities, the head, and the vocal apparatus.

Notwithstanding the large size of the olfactory tract at its junction with the brain the smelling centre has not yet been undisputedly made out. There are many portions of the brain the functions of which have not been discovered because present methods of observation are insufficient. There are certain phenomena that follow upon injury of other portions, such as loss of sensation, elevation of bodily temperature, incoördination, vertigo, but, as any one of these kinds of disturbances may be produced by injury to several different areas, strictly speaking we cannot regard such pathological processes as indicating physiological centralization.

The clustering of certain motor nerve beginnings for coördinating processes into closely aggregated nuclei, warrant, to a qualified extent, such terms as crying, laughing, sneezing, and vomiting centres, and as laughing and crying are regarded as emotional exhibitions, the conclusion has been jumped at that the medulla, where these nuclei are found, is the emotional centre. Then there is a sort of hazy idea derived from phrenological assumptions, that there is a centre for memory, another for sexuality, others for combativeness, mathematics, and so on.

Examining by reasoning processes certain faculties that are dependent upon brain integrity, we may arrive at conclusions that are valuable from both positive and negative points of view. The negations afforded by science make us intellectually superior to superstition, though they may not, for the nonce, give us " something else instead " of our fetiches.

SEEING, HEARING AND TOUCH have been considered incidentally in this article, and my contribution to THE AMERICAN NATURALIST, July, 1888, entitled "Cerebrology and Phrenology" contains a discussion of mental faculties in general and in detail from the old and new points of view.

TASTE and SMELL. These two special senses are associated in food discrimination to such an extent as to be often confused one with the other. As might be imagined, the simpler reflex organization of the lower invertebrates relating mouth motions to these senses grow more complex the higher the animal, until considerable brain tissue is concerned. For example, the infant wants to eat everything it sees and its arm and mouth reflexes respond to sight, smell, and taste in endeavors at swallowing everything visible, including its fist and the moon. Olfaction is the main food discriminating sense below the primates, the olfactory bulbs at the base of many lower mammalian brains being very large.

In 1884 I published the original view that the hippocampus major related the olfactory sense to the eating motions. The hippocampus major passes from the olfactory nerve roots backward and finally curls upward and forward to the post frontal region, where are centres for the lips, tongue, and deglutitory parts generally. The Huxley-Owen controversy over the hippocampus minor ended in the former demonstrating its presence in anthropoid ape brains. The animus of the denial was to show a radical difference between "lower animals" and man in the absence of a cerebral part.

I am not aware that anyone has preceded me in announcing the probable functions of the hippocampi. The major is large, and, in keeping with its size, must have subserved some very important life relation, and what is more likely, considering its beginning and termination, its relationship to other brain parts, and its zoological distribution, than that it brought the smelling, tasting, and eating apparatus into coöperation.

In man and the higher apes the olfactory has given way to optic intelligence generally, and in judging of food wholesomeness the eyesight is relied upon mainly, which would

account for the obsolescing features of the major in man, and the absence of the minor below the apes.

The minor projects into the occipital lobe in the region allotted to optic intelligence. The relative sizes of the hippocampi may be explained by remembering that millions of years may have been occupied by Mammalia with olfaction as the main means of food discrimination in their evolution, and that relatively much less time has elapsed since the apes and man first appeared. The hippocampus minor develops as the optic sense becomes the superior means of food judgment; and as the olfactory importance diminishes, the hippocampus major degenerates.

That the taste and olfactory centres are not definitely determined depends, in my opinion, upon the intimate blending of these senses with motor eating centres, paralysis of which becomes so noticeable as to overshadow the sense loss, which latter may be overlooked or regarded as not necessarily an associated derangement. Lesion of the temporal lobes destroying the smelling sense may indicate no more than that olfactory fibres pass through those parts. Taste has reflex connections of a lower than cerebral nature that regulate many involuntary acts concerned in eating, but by association pretty extensive brain distributions are also concerned, more particularly optic, and the glosso-labial motor areas near the sulcus of Rolando. So we may say taste and smell are more generalized than centralized through the brain, and that in man the smelling sense is losing importance.

Consciousness is at its fullest when we possess every faculty intact. Deprivation of the special senses necessarily interferes with consciousness, though, as in the Laura Bridgman case, the possession of a single sense, which has been trained to subserve purposes of contact and communication with the outer world, may suffice. Circulatory disturbances in the brain affect consciousness in various ways, sometimes abolishing it for a time. Proper regard for these and other such matters as sleep, epilepsy, compression of the brain, and a multitude of considerations requiring too much space to even epitomize here, lead me to deny that consciousness has any

localized area in the brain, but resides in the total functionating parts of that organ. For instance, in a healthy brain the entire nervous and vascular tissue, in its solidarity, is the seat of consciousness. Derangement of a part may interfere with action of the brain as a whole, and until adjustment to altered conditions has occurred, there may be deranged or lost consciousness. Now if an attempt at compensation be made by reparative processes, a new consciousness may be instituted, but correspondingly degraded in proportion to whatever permanent damage the brain may have sustained. So while there is no special cerebral seat of consciousness, the entire brain is concerned therein, and the quantity and quality of consciousness will depend upon the equivalent integrity, construction, and size of the brain as a whole.

MEMORY has been well demonstrated as consisting of memories. There is a memory of what has been learned by eyesight, located in the back part of the brain; forward of this, a memory of all that has been acquired through hearing. Touch memories are scattered over the brain surface co-extensively with motor centres for the peripheries from which the impression proceeds. This is based on Munk's claim that tactile and motor centres coincide, though this is still under discussion. Taste and smell may be safely inferred as having probable centres, and the memory of things tasted and smelt reside therein. In addition to these there are motor memories (the "*Bewegungsbilder*" of Kussmaul), which lie between, and in, the muscles, the nerves that innervate them, and the cells that lie in the outer part of the brain, and which are connected with those nerves. Then memory has no special seat, but has many brain localities devoted to different kinds of memories.

VOLITION. That the so-called will power controls such a great number of parts would of itself argue that volition exercised the centres of innervation of those parts.

As volition is merely the strongest impulse, and is aroused or checked by single or multiple reflexes, the centres for which are scattered throughout the spinal cord and brain, it is plain that there can be no special seat for the will power. The voluntary activities are the measure of volition and all the

body activities, voluntary and involuntary, instigate it. Molecular changes in and about us influence and control it; digestive processes, fatigue, rest, good or bad air, sicknesses, as well as mental impressions, guide it, raise and depress it. Its starting point is everywhere in the body, its reflex centres are everywhere in the brain.

SEXUALITY (to borrow a phrenological term) is sometimes apparently augmented by brain injury. This I interpret as indicating that full brain integrity diverts or holds in check the manifestations of an appetite that belongs to every cell of the body. There are automatic spinal cord centres connecting the genitals through the nervi erigenates, but so far as intelligence is concerned in sexuality, a great number of mental associations exist differing between individuals; these are mainly optic in man, and olfactory in most other Mammalia. There need no more be a special localization in the brain for sexuality than for hunger, and these two instincts are at the very foundation of life, and exist in every part of the body, controlling, directly or indirectly, every act and thought. So hunger and sexual desire are co-extensive with the distribution of volition throughout the body and brain.

THE EMOTIONS have vaguely been regarded as having several centres or a single centre. Often in physiological writings we encounter the term "emotional centre" and reasons more or less incorrect have been advanced locating this "emotional centre" at the base of the brain.

Emotionalism in a broad sense is nothing more nor less than degrees of excitement. So from this standpoint it is a condition, an exaltation or depression of the nerve centres, and hence it would be absurd to look for its centre. Joy, grief, anger, fear, jealousy, are all conditions which may engage every cell in the body at times. The fact that there may be crying and laughing centres in the medulla do not constitute that portion an emotional centre any more than we are justified in calling the leg centres in the brain cortex, kicking centres. The laugh and cry may be purely automatic and without reference to the emotions at all. Besides, some emotional exhibitions, such as tremblings and pallor, indicate that during emotional excite-

ment nerve force is pretty well diffused throughout the body, and that no particular set of nerves is engaged. It would seem that in such instances there is excellent evidence of the absence of an emotional centre and the shaken up general nervous system can find no special outlet for the feeling.

When a rupture of a blood vessel in the motor centres of the brain causes paralysis, and in brain degenerative states, such as are induced by alcoholism and senility, there is an increase of emotionalism; the patient may cry and laugh easily, but in such instances the higher control is lost, impressions are diverted from former channels in the brain to the more automatic ones lower down, but the emotionalism is the product of brain injury and is a debased condition, and hence has no centre in the brain. The fact that the brain base at its junction with the spinal cord has laughing and crying reflex centres may warrant this area being named an emotional centre in a very limited sense, but strictly speaking, there can be no such thing as a centre for the emotions, for laughing and crying are but two among a great number of emotional exhibitions and they may occur independently of consciousness.

Instinct and Reason. A study of the construction of the nervous system should convince anyone that the more definite the tracts that pass between nerve centres and muscles engaged in habitual performances, the more instinctively are motions enabled. Muscles are developed by exercise, and certain kinds of work give special peculiarities to those muscles, and it is reasonable to suppose that nerve bundles passing to such muscles, and the nerve centres in the cord and brain are, through participating in the work, also developed, arranged, and adjusted, to enable harmonious adaptation of means to ends. When one becomes an adept at piano playing, a trade, etc., many complicated acts may be performed "instinctively," automatically, and even unconsciously, as during somnambulism, some epileptic feats, or in the routine work of daily normal life. We would infer from this that the acts instinctively performed by animals, even when just born, are reflexes that depend upon a definite arrangement of nerve strands transmitted in many cases through ages.

Reason, on the other hand, is often engaged in holding such reflexes in check. Deliberation, hesitation, doubt, antagonize instinct in many ways, and the reasoning processes being the later acquired by all animals are the first to be weakened by age or debility. There can be no such definiteness about the nerve tissues engaged in reasoning processes as in instinctively, automatically performed acts.

An instinct may have its impetus in a brain centre that controls the motions of any particular group of muscles, therefore there can be no special seat for instinct in general but as many different seats as there are brain areas concerned in coördinating the multitude of muscular acts. Reason involves every sense and sometimes controls all voluntary motions, hence its seat cannot be special, and, its operations being general, so must be its functionating mechanism. Furthermore, the more recently formed and less definitely constructed fasiculi and nerve cells are apparently more engaged in reasoning processes than the more fully elaborated and perfected strands for simpler reflex acts, such as are concerned in instinctively performed motions.

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